## CLAIMS

What is claimed is:

1. A droplet ejection apparatus having a driving circuit, a reciprocating mechanism and a plurality of droplet ejection heads each including a cavity filled with a liquid, a nozzle communicated with the cavity and an actuator, the droplet ejection head ejecting the liquid within the cavity through the nozzle in the form of droplets by driving the actuator by means of the driving circuit to change an internal pressure of the cavity while moving the plurality of droplet ejection heads relatively with respect to a droplet receptor by the reciprocating mechanism so that the ejected droplets land on the droplet receptor, the droplet ejection apparatus comprising:

ejection failure detecting means for detecting an ejection failure of the droplet ejected through each of the nozzles and a cause thereof; and

recovery means for carrying out recovery processing for the droplet ejection heads to eliminate the cause of the ejection failure of the droplet;

wherein the ejection failure detecting means detects the ejection failure with respect to a droplet ejection operation of each droplet ejected through the nozzles when the plurality of droplet ejection heads eject the droplets onto the droplet receptor, and wherein, in the case where the ejection failure is detected, the droplet ejection apparatus interrupts the ejection of the droplets onto the droplet receptor and make the recovery means carry out the recovery processing in accordance with the cause of the ejection failure.

2. The droplet ejection apparatus as claimed in claim 1, wherein the droplet ejection apparatus is adapted to confirm whether or not the ejection failure is eliminated through a detecting operation by the ejection failure detecting means

after the recovery means carried out the recovery processing in accordance with the cause of the ejection failure.

3. The droplet ejection apparatus as claimed in claim 2, wherein the detecting operation by the ejection failure detecting means for the confirmation is carried out at a droplet ejection operation in a flushing process for the nozzle.

4. The droplet ejection apparatus as claimed in claim 2, wherein the droplet ejection apparatus resumes the remaining ejection operation of the droplets onto the droplet receptor after carrying out the detecting operation by the ejection failure detecting means for the confirmation.

5. The droplet ejection apparatus as claimed in claim 2, further comprising droplet receptor transporting means which carries out discharge and feed of the droplet receptor;

wherein the droplet ejection apparatus is adapted to operate the droplet receptor transporting means to discharge the droplet receptor from and feed another droplet receptor to the droplet ejection apparatus to carry out a new and same droplet ejection operation with respect to the fed droplet receptor after carrying out the detecting operation by the ejection failure detecting means for the confirmation.

6. The droplet ejection apparatus as claimed in claim 2, wherein, in the case where the ejection failure is detected through the detecting operation by the ejection failure detecting means for the confirmation, the recovery means carries out the recovery processing again.

7. The droplet ejection apparatus as claimed in claim 6, wherein, in the case where the recovery means carries out the recovery processing again when the ejection failure was detected through the detecting operation by the ejection failure detecting means for the confirmation, the recovery means carries

out the recovery processing in accordance with the cause of the ejection failure.

8. The droplet ejection apparatus as claimed in claim 1, wherein the recovery means includes: wiping means for carrying out a wiping process in which a nozzle surface of the droplet ejection heads where the nozzles are arranged is wiped with a wiper; flushing means for carrying out a flushing process by which the droplets are preliminarily ejected through the nozzles by driving the actuator; and pumping means for carrying out a pump-suction process with the use of a pump connected to a cap that covers the nozzle surface of the droplet ejection heads.

9. The droplet ejection apparatus as claimed in claim 8, wherein the causes of the ejection failure that the ejection failure detecting means can detect include: intrusion of an air bubble into the cavity; thickening of the liquid in the vicinity of the nozzle due to drying; and adhesion of paper dust in the vicinity of an outlet of the nozzle; and

wherein the recovery means carries out the pump-suction process by the pumping means in case of the intrusion of an air bubble, the flushing process by the flushing means or the pump-suction process by the pumping means in case of the thickening of the liquid due to drying, and at least the wiping process by the wiper in case of the adhesion of paper dust.

10. The droplet ejection apparatus as claimed in claim 1, wherein each of the droplet ejection heads includes a diaphragm that is displaced when the actuator is driven, and wherein the ejection failure detecting means detects a residual vibration of the diaphragm and determines an ejection failure based on a vibration pattern of the detected residual vibration of the diaphragm.

11. The droplet ejection apparatus as claimed in claim 10, wherein the ejection failure detecting means includes judging

means for judging a cause of the ejection failure in the case where it is determined that there is the ejection failure of the droplets in the droplet ejection heads on the basis of the vibration pattern of the residual vibration of the diaphragm.

12. The droplet ejection apparatus as claimed in claim 11, wherein the vibration pattern of the residual vibration of the diaphragm includes a cycle of the residual vibration.

13. The droplet ejection apparatus as claimed in claim 12, wherein the judging means judges that: an air bubble has intruded into the cavity in the case where the cycle of the residual vibration of the diaphragm is shorter than a predetermined range of cycle; the liquid in the vicinity of the nozzle has thickened due to drying in the case where the cycle of the residual vibration of the diaphragm is longer than a predetermined threshold; and paper dust is adhering in the vicinity of the outlet of the nozzle in the case where the cycle of the residual vibration of the diaphragm is longer than the predetermined range of cycle and shorter than the predetermined threshold.

14. The droplet ejection apparatus as claimed in claim 10, wherein the ejection failure detecting means includes an oscillation circuit and the oscillation circuit oscillates in response to an electric capacitance component of the actuator that varies with the residual vibration of the diaphragm.

15. The droplet ejection apparatus as claimed in claim 14, wherein the ejection failure detecting means includes a resistor element connected to the actuator, and the oscillation circuit forms a CR oscillation circuit based on the electric capacitance component of the actuator and a resistance component of the resistor element.

16. The droplet ejection apparatus as claimed in claim 14, wherein the ejection failure detecting means includes an F/V

converting circuit that generates a voltage waveform in response to the residual vibration of the diaphragm from a predetermined group of signals generated based on changes in an oscillation frequency of an output signal from the oscillation circuit.

17. The droplet ejection apparatus as claimed in claim 16, wherein the ejection failure detecting means includes a waveform shaping circuit that shapes the voltage waveform in response to the residual vibration of the diaphragm generated by the F/V converting circuit into a predetermined waveform.

18. The droplet ejection apparatus as claimed in claim 17, wherein the waveform shaping circuit includes: DC component eliminating means for eliminating a direct current component from the voltage waveform of the residual vibration of the diaphragm generated by the F/V converting circuit; and a comparator that compares the voltage waveform from which the direct current component thereof has been eliminated by the DC component eliminating means with a predetermined voltage value; and

wherein the comparator generates and outputs a rectangular wave based on this voltage comparison.

19. The droplet ejection apparatus as claimed in claim 18, wherein the ejection failure detecting means includes measuring means for measuring the cycle of the residual vibration of the diaphragm based on the rectangular wave generated by the waveform shaping circuit.

20. The droplet ejection apparatus as claimed in claim 19, wherein the measuring means has a counter, and measures either a time between rising edges of the rectangular wave or a time between a rising edge and falling edge of the rectangular wave by counting pulses of a reference signal with the counter.

21. The droplet ejection apparatus as claimed in claim 1,

further comprising:

switching means for switching a connection of the actuator from the driving circuit to the ejection failure detecting means after carrying out the droplet ejection operation by driving the actuator.

22. The droplet ejection apparatus as claimed in claim 21, further comprising one or more ejection failure detecting means and one or more switching means;

wherein the switching means corresponding to the droplet ejection head that has carried out the droplet ejection operation switches the connection of the actuator from the driving circuit to the corresponding ejection failure detecting means, and then the switched ejection failure detecting means detects an ejection failure of the droplets.

23. The droplet ejection apparatus as claimed in claim 1, wherein the actuator includes an electrostatic actuator.

24. The droplet ejection apparatus as claimed in claim 1, wherein the actuator includes a piezoelectric actuator having a piezoelectric element and using a piezoelectric effect of the piezoelectric element.

25. The droplet ejection apparatus as claimed in claim 1, further comprising:

storage means for storing a cause of the ejection failure of the droplets detected by the ejection failure detecting means in association with the nozzle for which the detection was carried out.

26. The droplet ejection apparatus as claimed in claim 1, wherein the droplet ejection apparatus includes an ink jet printer.

27. A droplet ejection apparatus having a driving circuit,

a reciprocating mechanism and a plurality of droplet ejection heads each including a cavity filled with a liquid, a nozzle communicated with the cavity, and an actuator, the droplet ejection head ejecting the liquid within the cavity through the nozzle in the form of droplets by driving the actuator by means of the driving circuit to change an internal pressure of the cavity while moving the plurality of droplet ejection heads relatively with respect to a droplet receptor by the reciprocating mechanism so that the ejected droplets land on the droplet receptor, the droplet ejection apparatus comprising:

ejection failure detecting means for detecting an ejection failure of the droplet ejected through each of the nozzles and a cause thereof;

counting means for counting the number of ejection failures detected by the ejection failure detecting means; and

recovery means for carrying out recovery processing for the droplet ejection heads to eliminate the cause of the ejection failure of the droplet;

wherein the ejection failure detecting means detects the ejection failure with respect to a droplet ejection operation of each droplet ejected through the nozzles when the plurality of droplet ejection heads eject the droplets onto the droplet receptor, and wherein, in the case where the number of ejection failures with respect to the droplet receptor counted by the counting means exceeds a predetermined reference value, the droplet ejection apparatus interrupts the ejection of the droplets onto the droplet receptor and make the recovery means carry out the recovery processing in accordance with the cause of the ejection failure.

28. The droplet ejection apparatus as claimed in claim 27, wherein the reference value is changeable.

29. The droplet ejection apparatus as claimed in claim 28, wherein the droplet ejection apparatus has a plurality of

operation modes that respectively correspond to reference values different from each other, and is adapted to be able to select any one of the operation modes.

30. The droplet ejection apparatus as claimed in claim 27, wherein the droplet ejection apparatus is adapted to confirm whether or not the ejection failure is eliminated through a detecting operation by the ejection failure detecting means after the recovery means carried out the recovery processing in accordance with the cause of the ejection failure.

31. The droplet ejection apparatus as claimed in claim 30, wherein the detecting operation by the ejection failure detecting means for the confirmation is carried out at a droplet ejection operation in a flushing process for the nozzle.

32. The droplet ejection apparatus as claimed in claim 30, wherein the droplet ejection apparatus resumes the remaining ejection operation of the droplets onto the droplet receptor after carrying out the detecting operation by the ejection failure detecting means for the confirmation.

33. The droplet ejection apparatus as claimed in claim 30, further comprising droplet receptor transporting means which carries out discharge and feed of the droplet receptor;

wherein the droplet ejection apparatus is adapted to operate the droplet receptor transporting means to discharge the droplet receptor from and feed another droplet receptor to the droplet ejection apparatus to carry out a new and same droplet ejection operation with respect to the fed droplet receptor after carrying out the detecting operation by the ejection failure detecting means for the confirmation.

34. The droplet ejection apparatus as claimed in claim 30, wherein, in the case where the ejection failure is detected through the detecting operation by the ejection failure

detecting means for the confirmation, the recovery means carries out the recovery processing again.

35. The droplet ejection apparatus as claimed in claim 34, wherein, in the case where the recovery means carries out the recovery processing again when the ejection failure was detected through the detecting operation by the ejection failure detecting means for the confirmation, the recovery means carries out the recovery processing in accordance with the cause of the ejection failure.

36. The droplet ejection apparatus as claimed in claim 27, wherein the recovery means includes: wiping means for carrying out a wiping process in which a nozzle surface of the droplet ejection heads where the nozzles are arranged is wiped with a wiper; flushing means for carrying out a flushing process by which the droplets are preliminarily ejected through the nozzles by driving the actuator; and pumping means for carrying out a pump-suction process with the use of a pump connected to a cap that covers the nozzle surface of the droplet ejection heads.

37. The droplet ejection apparatus as claimed in claim 36, wherein the causes of the ejection failure that the ejection failure detecting means can detect include: intrusion of an air bubble into the cavity; thickening of the liquid in the vicinity of the nozzle due to drying; and adhesion of paper dust in the vicinity of an outlet of the nozzle; and

wherein the recovery means carries out the pump-suction process by the pumping means in case of the intrusion of an air bubble, the flushing process by the flushing means or the pump-suction process by the pumping means in case of the thickening of the liquid due to drying, and at least the wiping process by the wiper in case of the adhesion of paper dust.

38. The droplet ejection apparatus as claimed in claim 27, wherein each of the droplet ejection heads includes a diaphragm

that is displaced when the actuator is driven, and wherein the ejection failure detecting means detects a residual vibration of the diaphragm and determines an ejection failure based on a vibration pattern of the detected residual vibration of the diaphragm.

39. The droplet ejection apparatus as claimed in claim 38, wherein the ejection failure detecting means includes judging means for judging a cause of the ejection failure in the case where it is determined that there is the ejection failure of the droplets in the droplet ejection heads on the basis of the vibration pattern of the residual vibration of the diaphragm.

40. The droplet ejection apparatus as claimed in claim 39, wherein the vibration pattern of the residual vibration of the diaphragm includes a cycle of the residual vibration.

41. The droplet ejection apparatus as claimed in claim 40, wherein the judging means judges that: an air bubble has intruded into the cavity in the case where the cycle of the residual vibration of the diaphragm is shorter than a predetermined range of cycle; the liquid in the vicinity of the nozzle has thickened due to drying in the case where the cycle of the residual vibration of the diaphragm is longer than a predetermined threshold; and paper dust is adhering in the vicinity of the outlet of the nozzle in the case where the cycle of the residual vibration of the diaphragm is longer than the predetermined range of cycle and shorter than the predetermined threshold.

42. The droplet ejection apparatus as claimed in claim 38, wherein the ejection failure detecting means includes an oscillation circuit and the oscillation circuit oscillates in response to an electric capacitance component of the actuator that varies with the residual vibration of the diaphragm.

43. The droplet ejection apparatus as claimed in claim 42,

wherein the ejection failure detecting means includes a resistor element connected to the actuator, and the oscillation circuit forms a CR oscillation circuit based on the electric capacitance component of the actuator and a resistance component of the resistor element.

44. The droplet ejection apparatus as claimed in claim 42, wherein the ejection failure detecting means includes an F/V converting circuit that generates a voltage waveform in response to the residual vibration of the diaphragm from a predetermined group of signals generated based on changes in an oscillation frequency of an output signal from the oscillation circuit.

45. The droplet ejection apparatus as claimed in claim 44, wherein the ejection failure detecting means includes a waveform shaping circuit that shapes the voltage waveform in response to the residual vibration of the diaphragm generated by the F/V converting circuit into a predetermined waveform.

46. The droplet ejection apparatus as claimed in claim 45, wherein the waveform shaping circuit includes: DC component eliminating means for eliminating a direct current component from the voltage waveform of the residual vibration of the diaphragm generated by the F/V converting circuit; and a comparator that compares the voltage waveform from which the direct current component thereof has been eliminated by the DC component eliminating means with a predetermined voltage value; and

wherein the comparator generates and outputs a rectangular wave based on this voltage comparison.

47. The droplet ejection apparatus as claimed in claim 46, wherein the ejection failure detecting means includes measuring means for measuring the cycle of the residual vibration of the diaphragm based on the rectangular wave generated by the waveform shaping circuit.

48. The droplet ejection apparatus as claimed in claim 47, wherein the measuring means has a counter, and measures either a time between rising edges of the rectangular wave or a time between a rising edge and falling edge of the rectangular wave by counting pulses of a reference signal with the counter.

49. The droplet ejection apparatus as claimed in claim 27, further comprising:

switching means for switching a connection of the actuator from the driving circuit to the ejection failure detecting means after carrying out the droplet ejection operation by driving the actuator.

50. The droplet ejection apparatus as claimed in claim 49, further comprising one or more ejection failure detecting means and one or more switching means;

wherein the switching means corresponding to the droplet ejection head that has carried out the droplet ejection operation switches the connection of the actuator from the driving circuit to the corresponding ejection failure detecting means, and then the switched ejection failure detecting means detects an ejection failure of the droplets.

51. The droplet ejection apparatus as claimed in claim 27, wherein the actuator includes an electrostatic actuator.

52. The droplet ejection apparatus as claimed in claim 27, wherein the actuator includes a piezoelectric actuator having a piezoelectric element and using a piezoelectric effect of the piezoelectric element.

53. The droplet ejection apparatus as claimed in claim 27, further comprising:

storage means for storing a cause of the ejection failure of the droplets detected by the ejection failure detecting means

in association with the nozzle for which the detection was carried out.

54. The droplet ejection apparatus as claimed in claim 27, wherein the droplet ejection apparatus includes an ink jet printer.